

Appendix B

Electric and Magnetic Fields Background Information

Electric and Magnetic Fields

Extensive research has been conducted to determine if exposure to electric or magnetic fields may cause or promote adverse health effects. Much of this research has focused on determining whether or not electric and magnetic fields (EMF) exposure at some level has adverse health effects, rather than on identifying the specific exposure level at which such effects may occur. The National Institute of Environmental Health Sciences (NIEHS) was mandated by Congress to conduct a research program, literature review, and health assessment on EMF effects, including an extensive scientific and public review processes. Following 6 years of research, the NIEHS released its report in June 1999 entitled *Health Effects from Exposure to Power-line Frequency Electric and Magnetic Fields* (NIEHS 1999). The report studied the effects of the extremely low frequency range (ELF) fields generated by the power lines in the United States.

The NIEHS report's Executive Summary concludes that "The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak." The report continues, "The probability that EMF exposure is truly a health hazard is currently small." The report also states that ELF-EMF exposure "cannot be recognized as entirely safe," given that epidemiological studies (studies of disease patterns in people) demonstrate a fairly consistent pattern of small increased risk with increasing exposures for chronic lymphocytic and childhood leukemia. On the other hand, the report explains that the results of laboratory experiments fail to demonstrate any consistent pattern supporting the epidemiological findings. The report continues that the epidemiological findings are weakened by this lack of support from laboratory data, though the epidemiological findings cannot be completely discounted.

The most significant source for the NIEHS report was the NIEHS Working Group Report, which resulted from a 9-day meeting in June 1998. The Working Group considered all literature relevant to the potential effects of power-frequency EMF on health, including cancers of several types, adverse pregnancy outcomes, chronic illnesses (for example, Alzheimer's disease and amyotrophic lateral sclerosis also known as Lou Gehrig's disease), and neurobehavioral changes (for example, depression, learning, and performance). The Working Group found limited support for a causal relationship between childhood leukemia and residential exposure to EMF, and between adult chronic lymphocytic leukemia and employment with potentially high-magnetic field exposure. Based on this assessment and charged with ranking EMF, according to the International Agency for Research on Cancer criteria, the Working Group assigned EMF a 2B ranking, which translates to "possible human carcinogen." For all other health outcomes, the Working Group concluded that the evidence was inadequate.

The NIEHS report included an assessment of EMF exposures measured in the United States from home and office appliances. Based on data from 24-hour personal monitors worn by individuals, exposures measured within the home averaged 0.8 milligauss (mG) for time not in bed and 0.5 mG for time spent in bed. Personal exposures at work averaged 1.0 mG. A number of common household appliances generate EMF, with the highest fields typically coming from microwave ovens, toaster ovens, ceiling heaters, and refrigerators. While this exposure information may provide a basis of comparison for evaluating EMF exposure associated with power lines, uncertainty exists on whether long-term, lower exposures (typically associated with power lines) and short-term, higher exposures (typically associated with appliances) are comparable in their potential effects on human health (NIEHS 1999).

An independent paper by Dr. Sander Greenland (University of California, Los Angeles) and colleagues, entitled "A Pooled Analysis of Magnetic Fields, Wire Codes, and Childhood Leukemia," (Greenland et al. 2000) has been published in the journal *Epidemiology*. The work was funded by NIEHS. The authors concluded: (1) an effect of magnetic fields below 3.0 mG is unlikely or too small to be detected in epidemiological studies; and (2) there is suggestive evidence that an association between magnetic fields greater than 3.0 mG and childhood leukemia exists.

Another paper describing the results of a pooled analysis of magnetic fields and childhood leukemia was published in the September 2000 issue of *British Journal of Cancer*. Dr. Anders Ahlbom (Karolinska Institute, Sweden) and colleagues conducted the analysis funded by the European Union (Ahlbom 2000). This pooled analysis is based on original, individual-level data rather than a review of existing studies. The study examined whether there is an association between magnetic fields and leukemia. The authors concluded “We did not find any evidence of an increased risk of childhood leukemia at residential magnetic field levels less than 4.0 mG. We did, however, find a statistically significant relative risk estimate of two for childhood leukemia in children with residential exposure to EMF greater than 4.0 mG during the year prior to diagnosis. Less than one percent of subjects were in this highest exposure category.” The report also states that the explanation for the elevated risk is unknown but suggests that selection bias may have accounted for some of the increase.

In light of the literature review and studies conducted by NIEHS and presented in its summary report, the NIEHS encourages passive regulatory action on EMF. This includes a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS states that the power industry should continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

An additional comprehensive review of existing studies, which included review and comment by the public, was recently completed on behalf of the California Public Utilities Commission led by three scientists who work for the California Department of Health Services (DHS). This Risk Evaluation, available in its entirety on the Internet at <http://www.dhs.ca.gov/ehib/emf/RiskEvaluation/riskeval.html>, provides an evaluation of the animal, laboratory and human evidence that shows how exposure to 50/60 Hz magnetic fields may or may not increase human health risks. Like many other evaluations, the focus was on determining whether or not EMF exposure at some level has adverse human health effects, rather than on identifying the specific exposure level at which such potential health effects may occur. Three DHS scientists reviewed studies covering EMFs from power lines, wiring in buildings, some jobs, and appliances. The DHS study Executive Summary states, “With the exception of miscarriage, which is common, the other diseases for which EMFs may be a contributing cause (childhood leukemia, adult brain cancer, Lou Gehrig’s Disease) have low incidence... The vast majority (99% to 99.9%) of highly exposed (EMF) people would still not contract these diseases... However, if EMFs do contribute to the cause of these conditions, even the low fractions of attributable cases and the size of accumulated lifetime risk of highly-exposed individuals could be of concern to regulators” (DHS 2002).